

# Anti-Infective Endotracheal Tube

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TITLE OF THE INVENTION

Anti-Infective Endotracheal Tube

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of the following U.S. Provisional Application:

5           No. 60/411,177, filed September 17, 2002.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR  
DEVELOPMENT

Not Applicable.

REFERENCE TO A "SEQUENTIAL LISTING," A TABLE, OR A COMPUTER  
10       PROGRAM LISTING APPENDIX SUBMITTED ON A COMPACT DISC

Not Applicable.

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

15       The invention involves catheters usable in medical treatments of a condition  
of a living body, and more particularly, catheters that can release antimicrobial  
agents, antibiofilm agents, electric radiation, or ultrasound radiation.

## DESCRIPTION OF RELATED ART

The related art can be reviewed via the following issued patents, the full disclosures of which are all incorporated herein by this reference:

- 6,235,024 Catheters System Having Dual Ablation Capability
- 5 5,819,723 Methods And Apparatus For Reducing Tracheal Infection
- 5,638,812 Coated Medico-Surgical Devices
- 5,582,167 Methods And Apparatus For Reducing Tracheal Infection Using  
Subglottic Irrigation, Drainage And Servoregulation Of  
Endotracheal Tube Cuff Pressure
- 10 5,544,648 Device For Intratracheal Ventilation And Intratracheal Pulmonary  
Ventilation Including Reverse Venturi
- 5,499,625 Esophageal-Tracheal Double Lumen Airway
- 5,389,074 Body Insertion Tube With Anesthetic Jacket
- 5,313,939 Endotracheal Tube For Topical Substance Delivery And  
15 Associated Method Of Use
- 5,143,062 Endotracheal Tube Having Irrigation Means
- 4,446,864 Emergency Ventilation Tube
- 3,087,493 Endotracheal Tube

Although some prior endotracheal tubes have means for releasing into a body  
20 various medications, including steroids, antibiotics, irrigants, lubricants, antimicrobial  
agents, and antibiofilm agents, those same endotracheal tubes do not also have  
means for releasing into a body electrical energy, or means for releasing ultrasound  
energy, for therapeutic purposes. What is needed is an endotracheal tube that has  
means for releasing both medications and energy, for both treatment and prevention  
25 of physical problems.

## BRIEF SUMMARY OF THE INVENTION

A multi-lumen endotracheal tube comprises means for coating an inside and an outside surface of the endotracheal tube with antimicrobial and antibiofilm agents; means for releasing antimicrobial and antibiofilm agents from the endotracheal tube; 5 means for using electrical current to enhance the efficacy of the antimicrobial and antibiofilm agents; and means for using ultrasound energy to enhance the efficacy of the antimicrobial and antibiofilm agents. In another feature of the present invention, the multi-lumen tube further comprises an outer lumen, and a concentric inner lumen, and the outer lumen contains the means for coating, the means for releasing, 10 the means for using electrical current, and the means for using ultrasound energy. In another feature of the present invention, the inside and outside surfaces have a surface coating to reduce the buildup of bacteria on the surface.

## BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

Fig. 1 is a schematic side view of the tube of the present invention, illustrated 15 in use with a patient.

Fig. 2 is a side view of the tube of the present invention.

Fig. 3 is an end view of the tube of the present invention.

## DETAILED DESCRIPTION OF THE INVENTION

Referring to Fig. 1, a patient 10 has a tube 12 according to the present 20 invention inserted in him. The tube 12 includes an outer lumen 14 and an inner lumen 16. The inner lumen 16 is a tube that is concentric with the lumen 14, provides structural support, and serves as an airway for the patient to breathe. Both an outside surface of the outer lumen 14, and an inside surface of the inner lumen

16 have both antibiofilm and antimicrobial surface coatings to reduce the buildup of bacteria and biofilm on the surfaces.

Tubes with inner and outer concentric lumens are known in the art, such as the tubes disclosed in the following patents, the full disclosures of which are all  
5 incorporated herein by this reference:

tube 100 in U.S. Patent No. 5,819,723  
tube 100 in U.S. Patent No. 5,582,167  
multiple lumen tracheal or endotracheal tube 32 in U.S. Patent No. 5,544,648  
tube 12 and chamber 50 in U.S. Patent No. 5,389,074  
10 tube member 1, lumen 6, and conduit members 15 in U.S. Patent No.  
5,313,939  
lumens 15 and 16 in U.S. Patent No. 5,143,062  
“first, inner tube 18 and a larger diameter, outer tube 30” in U.S. Patent No.  
4,446,864  
15 outer and inner walls 3 and 4 in U.S. Patent No. 3,087,493

Referring to Fig. 2, the outer lumen 14 includes a series of ports 18 for dispensing both antimicrobial and antibiofilm agents. Ports in endotracheal tubes are known in the art, such as the ports disclosed in the following patents, the full disclosures of which are all incorporated herein by this reference:

20 outlets 66, 102, and 154 (for infusing drugs and monitoring pressure) in U.S. Patent No. 5,544,648  
perforations 52 (for delivering anesthetics) in U.S. Patent No. 5,389,074  
openings 13 (for delivering various medications, including steroids, antibiotics, irrigants, and lubricants) in U.S. Patent No. 5,313,939  
25 suction eye 17 in U.S. Patent No. 5,143,062

"Tube 30 is provided with a plurality of radially extending openings 32 which permit the passage of gas into and out of the interior of portion 30" in U.S.

Patent No. 4,446,864

ports 9 (for introducing beneficial fluids) in U.S. Patent No. 3,087,493

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U.S. Patent No. 5,638,812 discloses a tracheal tube having a surface coating to reduce the buildup of bacteria on the tube. The disclosure of such tube with such coating is incorporated herein by this reference.

The outer lumen 14 also includes spots 20 for radiating ultrasound waves,  
10 and spots 22 for radiating electrical waves. The following disclosures of U.S. Patent No. 6,235,024 are incorporated herein by this reference:

ablation element 13, which includes a wall 47, which comprises an ultrasound transducer

RF ablation means 52

15 "A high frequency current generator means 30 is part of the ablation catheter system 1, wherein an electrical conducting means 29 is coupled from the generator 30 to the ablation element 13. The high frequency energy generator means 30 may comprise a switch means for switching high frequency energy to radiofrequency spectrum, ultrasound frequency spectrum, or  
20 radiofrequency/ultrasound frequency overlapped spectrum. This switch means is an operator-initiated action to the appropriate ablation mode selected from the group consisting of radiofrequency ablation mode, ultrasound ablation mode, and simultaneous radiofrequency and ultrasound ablation mode. In each mode, the energy delivery may be continuous, pulsed,  
25 programmed, and the like."

The method of operating the ablation catheter, as described in the patent.

It is easily understood by those skilled in this technology that if treatment other than ablation is desired, the operator may simply use lower power settings of the current generator. Thus, the operator of the present invention may use the spots 20 and 22 to enhance the activity of the antimicrobial agents delivered through the ports 18, against the organisms embedded within the biofilm.

Referring to both Fig. 2 and Fig. 3, the tube 12 further includes a cuff 30. The cuff 30 is a standard cuff, known in the art, such as the cuffs disclosed in the following patents, the full disclosures of which are all incorporated herein by this reference:

- 10 cuff 150 in U.S. Patent No. 5,819,723
- cuff 106 in U.S. Patent No. 5,582,167
- cuffs 18 and 22 in U.S. Patent No. 5,499,625
- cuff 32 in U.S. Patent No. 5,389,074
- inflatable cuff 14 in U.S. Patent No. 5,143,062
- 15 "occluding device 19" in U.S. Patent No. 4,446,864

It should be understood that the invention is not intended to be limited to the specifics of the described preferred embodiments, but is defined by the accompanying claims. That is, although illustrative embodiments have been shown and described, a wide range of modification, changes, and substitution is contemplated in the foregoing disclosure. In some instances, some features of the disclosed embodiments may be employed without a corresponding use of the other features. Accordingly, it is appropriate that the appended claims be construed broadly and in a manner consistent with the scope of the invention..